CLAIMS

1. A polynucleotide encoding at least one structural protein of SARS-CoV-2 or a variant thereof, wherein the at least one structural protein is the spike (S) protein and wherein the polynucleotide comprises a first sequence region, said first sequence region comprising a nucleic acid sequence having at least ~~80~~95% identity to a member of the group consisting of SEQ ID NO: 7, 20, 26, 27, and 32.

2. The polynucleotide of claim 1, wherein said first sequence region is at least 95% identical to SEQ ID NO: 7 or at least 99% identical to SEQ ID NO: 7.

~~3. The polynucleotide of claim 2, wherein said first sequence region is at least 99% identical to SEQ ID NO: 7.~~

3~~4~~. The polynucleotide of claim 2~~3~~, wherein said first sequence region consists of SEQ ID NO: 7.

4~~5~~. The polynucleotide of claim 3~~4~~, wherein the encoded spike protein has a protein sequence of SEQ ID NO: 2.

5~~6~~. The polynucleotide of any of claims 1-4~~5~~, wherein at least 50% of the polynucleotide sequence is codon optimized.

~~7. The polynucleotide of claim 5, wherein said polynucleotide is a DNA.~~

~~8. The polynucleotide of claim 5, wherein said polynucleotide is an RNA.~~

6~~9~~. The polynucleotide of any of claims 1-5~~claim 8~~, wherein the polynucleotide is an mRNA.

7~~10~~. The polynucleotide of claim 6~~9~~, comprising a 5'UTR and a 3'UTR, wherein said 5'UTR comprises SEQ ID NO: 47 and said 3'UTR comprises SEQ ID NO: 48.

8~~11~~. The polynucleotide of claim 7~~10~~, wherein at least one uracil nucleoside is modified to be N1 -methylpseudouridine.

9~~12~~. The polynucleotide of claim 8~~11~~, wherein all uracil nucleosides are modified to be N 1 -methylpseudouridine.

10~~13~~. A nucleic acid vaccine comprising the polynucleotide of- any of claims 1-9~~claim 12~~.

11~~14~~. The nucleic acid vaccine of claim 10~~13~~, formulated in lipid nanoparticle (LNP).

12~~15~~. A pharmaceutical composition comprising the nucleic acid vaccine of claim 10~~4~~ and a pharmaceutically acceptable excipient.

13~~16~~. The pharmaceutical composition of claim 12~~5~~, comprising about 0.2 mg/mL mRNA of claim 6~~9~~.

14~~17~~. The pharmaceutical composition of claim 12 or 13~~16~~ which is suitable for intramuscular (IM) injection.

~~18. The pharmaceutical composition of claim 16 which is packaged as a 2 mL fill in a 3 mL glass vial.~~

~~19. A method of inducing an immune response in a subject comprising administering the nucleic acid vaccine of any of claims 13-14 or the pharmaceutical composition of any of claims 15-18.~~

~~20. The method of claim 19, wherein the immune response comprises a T-cell response.~~

~~21. The method of claim 19, wherein the immune response comprises a B cell response.~~

~~22. The method of claim 19, further comprising administering a booster subsequent to the first administration.~~

~~23. The method of claim 19, wherein the immune response in the subject is dose dependent.~~

~~24. The method of claim 23, wherein the dose-dependent immune response comprises induction of one or more of SARS-CoV-2 spike protein specific IgG, IgG1, IgG2a, IgG2b, IgM and IgA antibodies in the subject.~~

~~25. The method of claim 23, wherein the dose-dependent immune response comprises induction of one or more of IL-2+ T-cells, IL-4+ T-cells, and IFN-gamma+ T-cells.~~

~~26. A method of treating COVID-19 in a subject comprising administering the nucleic acid vaccine of any of claims 13-14 or the pharmaceutical composition of any of claims 15-18.~~

15~~27~~. ~~A method of preventing COVID-19 in a subject comprising administering~~Use of the nucleic acid vaccine of ~~any of~~ claim~~s~~ 10 or 11 ~~13-14~~ or the pharmaceutical composition of any of claims 12-14 ~~15-18~~ in the manufacture of a medicament for preventing, ~~-~~mitigating or ameliorating COVID-19 in a subject ~~to said subject~~.

~~28. A method of mitigating or ameliorating the physiologic effects or symptoms of COVID-19 in a subject comprising administering the nucleic acid vaccine of any of claims 13-14 or the pharmaceutical composition of any of claims 15-18 to said subject.~~

16~~29~~. The ~~method~~ use of ~~any of~~ claim~~s~~ ~~26-28~~15, wherein the dose to be administered is:

i. from about 5 µg to about 100 µg of the mRNA to the subject;
ii. about 16 µg of the mRNA;
iii. about 40 µg of the mRNA; or
iv. about 100 µg of the mRNA.

~~30. The method of any of claims 26-28, wherein the dose administered is about 16 µg of the mRNA to the subject.~~

~~31. The method of any of claims 26-28, wherein the dose administered is about 40 µg of the mRNA to the subject.~~

~~32. The method of any of claims 26-28, wherein the dose administered is about 100 µg of the mRNA to the subject.~~

~~33. The method of any of claims 26-28, wherein the volume administered is about 0.025 mL to about 0.5 mL of the pharmaceutical composition to the subject.~~

~~34. The method of any of claims 26-28, wherein the volume administered is about 0.025 mL, 0.05mL, 0.08mL, 0.2mL, or 0.5mL, of the pharmaceutical composition to the subject.~~

17~~35~~. The ~~method~~ use of ~~any of~~ claim~~s~~ -15 or 16~~26-34~~, ~~comprising administering~~wherein a second dose of the nucleic acid vaccine or pharmaceutical composition is to be administered after between about 1 and about 5 weeks of a first dose or after about 4 weeks of a first dose.

~~36. The method use of claim 35, wherein the second dose is to be administered about 4 weeks after said first dose.~~

18~~37~~. The ~~method~~ use of any of claims -15-17~~26-28~~, wherein:

i. anti-Spike protein IgG antibodies are to be detected in the subject by day 28 after receiving a first dose of the nucleic acid vaccine or pharmaceutical composition;

ii. anti-Spike protein IgG antibodies are present in an enhanced amount in the subject by day 42 after receiving a second dose of the nucleic acid vaccine or pharmaceutical composition; and/or

iii. anti-Spike protein IgG antibodies in the subject are greater than 10-fold the values of anti-Spike protein IgG antibodies in serum samples from SARS-CoV-2 convalescent patients.

~~38. The method of claim 37, wherein the anti-Spike protein IgG antibodies are present in an enhanced amount in the subject by day 42 after receiving a second dose of the nucleic acid vaccine or pharmaceutical composition.~~

~~39. The method of claim 37, wherein the anti-Spike protein IgG antibodies in the subject are greater than 10-fold the values of anti-Spike protein IgG antibodies in serum samples from SARS-CoV-2 convalescent patients.~~

19~~40~~. ~~A method of inducing SARS-CoV-2 neutralizing antibody production in a subject comprising administering~~ Use of the nucleic acid vaccine of ~~any of~~ claim~~s~~ ~~13-14~~10 or 11 or the pharmaceutical composition of any of claims ~~15-18~~12-14 in the manufacture of a medicament for inducing SARS-CoV-2 neutralizing antibody production in a subject ~~to said subject~~.

20~~41~~. The ~~method~~ use of claim ~~40~~19, wherein:

i. ~~-~~the SARS-CoV-2 neutralizing antibodies can be detected in the subject by day 28 after ~~administration~~the medicament has been administered;

ii. the SARS-CoV-2 neutralizing antibody production is enhanced in the subject at day 42 the medicament has been administered; and/or

iii. the level of neutralizing antibodies to SARS-CoV-2 is increased ten-fold by day 42.

~~42. The method of claim 41, wherein the SARS-CoV-2 neutralizing antibody production is enhanced in the subject at day 42 after receiving a second dose of the nucleic acid vaccine or pharmaceutical composition.~~

~~43. The method of claim 41, wherein the level of neutralizing antibodies to SARS-CoV-2 is increased ten-fold by day 42.~~